

Space Weather Technical Forecast

Issued on Friday, 26 January 2024 at 01:12 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: CME arrivals likely today, with G1 storms likely and a chance of G2 storms. Chance of Moderate solar activity.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low with only C-class flares, the largest a C5.5 from AR3559 at 25/1522 UTC. There are currently five sunspots on the visible disc, all in the western hemisphere. AR3561 and AR3559 are the two largest and most complex regions. AR3561 in the southwest appears to be undergoing some minor decay in areal extent, although this could be due to its increasing proximity to the limb, which is making assessing the magnetic structure more difficult. However, this region has produced the majority of the C-class flares over the past 24 hours. AR3559 in the northwest previously had a large delta region, but has simplified over the past 24 hours. AR3555 is situated very close to AR3561 which makes it difficult to determine the separation, and these could be considered one region. The remaining spot regions are small and simple.

There have been several CMEs emerge in the last 24 hours, none of which are thought likely to be Earth directed.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by ACE and DSCOVR, showed weak CME arrivals around 25/0537 UTC and 25/1357 UTC. Wind speeds were mostly between 380-460 km/s, peaking at 496 km/s at 25/0614 UTC. Density started below average but gradually increased to generally average levels. Total magnetic field strength was predominantly weak at 7nT or below, but increased through the afternoon to peak at 10 nT at 25/1435 UTC. Bz varied weakly between +/- 6nT. Phi angle was mostly negative (towards the Sun). Geomagnetic activity was Quiet throughout (Kp 0-2).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux was at background levels.

GOES16 high energy (greater than 2MeV) electron flux was predominantly at background levels. The associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold on a steady trend. At 26/0000UTC the 24-hour integrated fluence observation was 1.23e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Activity has declined over the past few days, but is expected to be Low to Moderate with a chance of isolated M-flares and a slight chance of an X-flare.

Solar Wind / Geomagnetic Activity: There is potential for at least three CME glancing blows through the forecast period. In addition, these CMEs are all expected at a similar time - early today (26 Jan), with the potential for them to either combine or arrive one after the other,

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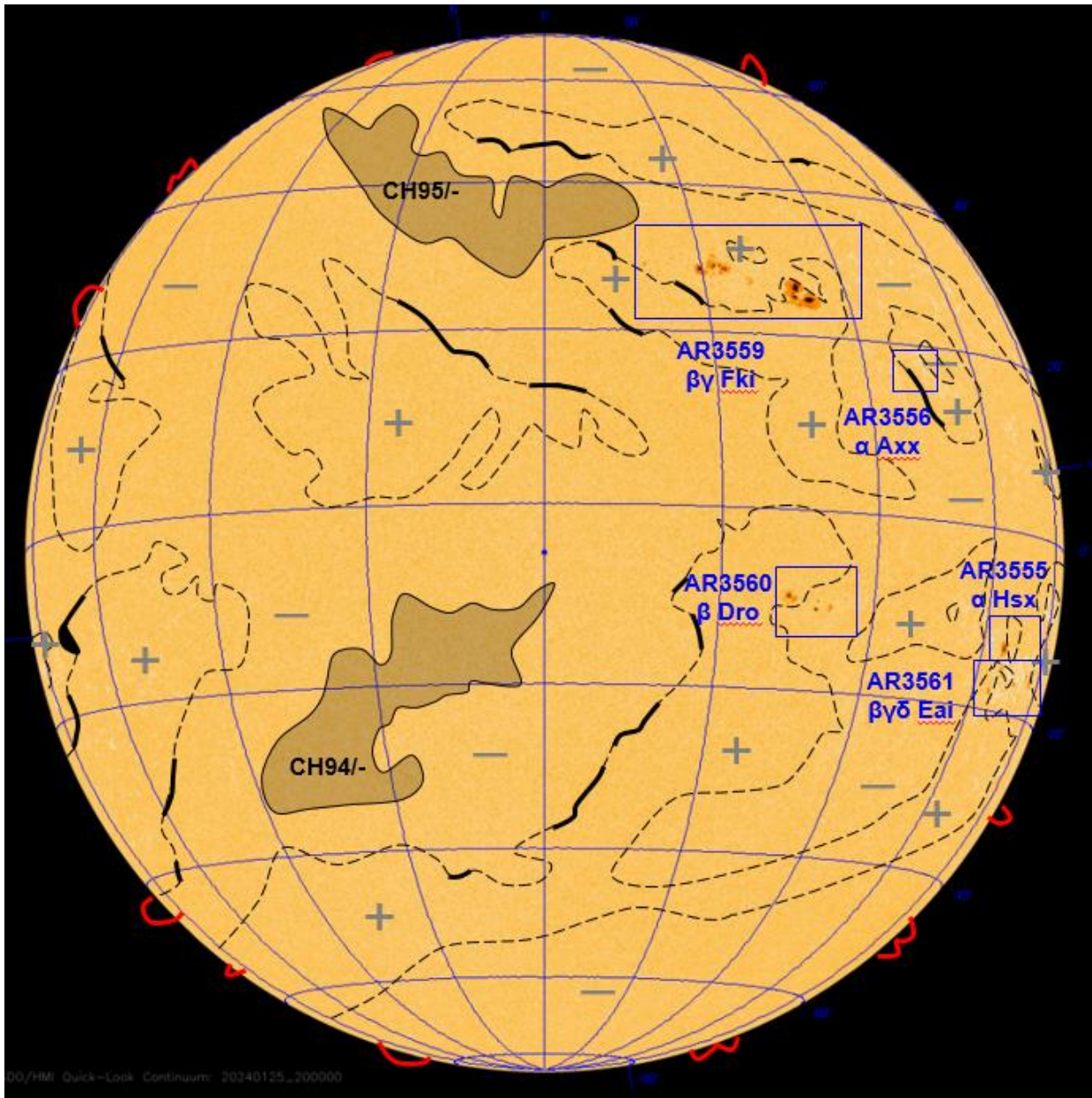
perhaps increasing any geomagnetic effects.

Overall, geomagnetic activity is expected to be mostly Quiet to Unsettled initially, with an increase expected today, perhaps step-wise if the various CMEs arrive separately, with Active to G1/Minor Storms likely and a chance of G2/Moderate Storms. There is a slight chance of G3/Strong Storms, should the CMEs combine favourably for this to occur. Geomagnetic activity should then gradually return to Quiet levels by Day 3 (28 Jan) after any residual CME effects have waned. During day 4 (29th) a coronal hole high speed stream is expected to arrive, and geomagnetic activity is expected to increase to Unsettled to Active levels, with a slight chance of a G1/Minor Storm.

Energetic Particles / Solar Radiation: There is a slight chance of radiation storms throughout, due to both AR3559 and AR3561.

The high energy electron (greater than 2MeV) flux is uncertain due to the effects of multiple possible CME arrivals on the forecast, but may rise later in the period, especially with the expected arrival of a HSS. There is a slight chance of electron fluence exceeding Active ($1e8$ integrated pfu), increasing to a chance for day 4 (29th). However, confidence is low regarding this.

Figure 1. Solar Analysis Valid 25/2000 UTC.



Key: Filament — , Prominence — , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There have been numerous CMEs seen in coronagraph imagery over recent days. The majority of these have been either northward or southward directed, but there is potential for several glancing blows in the forecast period. Of these, there are two CMEs which emerged on 22 and 23 January which are mostly directed below Earth's orbit, but are likely to give some impact at Earth. A third, also seen on 23 January, has the material of the CME directed well to the north of Earth, but a wider shock signature was visible in coronagraph imagery and this may also give a glancing blow. In addition, these CMEs are all expected at a similar time - from early today (26 Jan). However, it is possible that the weak CME arrivals yesterday may have been one or more of these expected arrivals. Overall confidence is low regarding the CME arrivals.

Geomagnetic activity is expected to be mostly Quiet to Unsettled initially, with an increase expected today, perhaps step-wise if the various CMEs arrive separately, with Active to G1/Minor Storms likely and a chance of G2/Moderate Storms. There is a slight chance of G3/Strong Storms, should the CMEs combine favourably for this to occur. Geomagnetic activity should then gradually return to Quiet levels by Day 3 (28 Jan) after any residual CME effects have waned. During day 4 (29th) a coronal hole high speed stream is expected to arrive, most likely from CH94 late in the day, although there is a chance of a weak connection to CH95 earlier in day 4 as CH95 extends slightly further west than CH94 but is also much further north. With a HSS connection during day 4 geomagnetic activity is expected to increase to Unsettled to Active levels, with a slight chance of a G1/Minor Storm.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	70	20	1	10
Strong	G3	No	15	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
22/1559	Partial	Filament	South-centre disc	620 km/s	25/2100 UTC	Now overdue glancing blow
23/0700	Partial	AR3559	Northeast	840 km/s	26/0000 UTC	Now overdue glancing blow
23/1230	Partial	AR3561	Southwest	650 km/s	26/0600 UTC	Glancing blow

Figure 2: MOSWOC Enlil

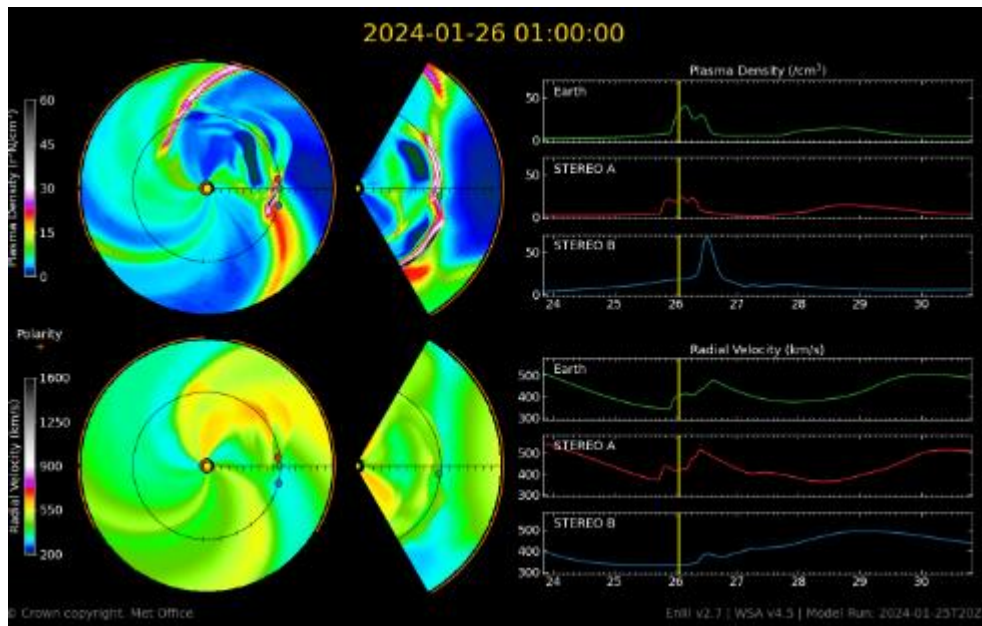
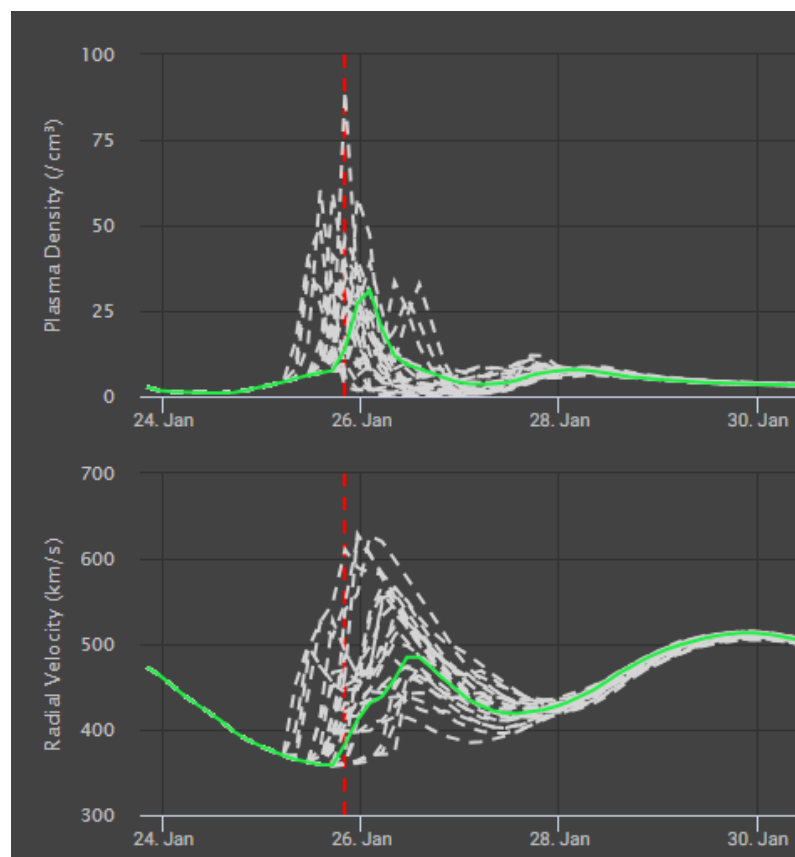


Figure 3: Enlil ensemble.



Radio Blackouts - X-Ray Flares:

Solar activity has been Low, as activity has declined. The largest event of the past 24 hours was a C5.5 at 25/1522 UTC from AR3559.

There are now five sunspots on the visible disc. AR3561 and AR3559 remain the two largest and most complex regions. AR3561 in the southwest appears to have recently shown some minor decay in areal extent. However, this could be due to AR3561's approach to the limb, which is increasingly making assessing the magnetic structure more difficult. Therefore the previously classification of Eai/beta-gamma-delta has been maintained. The large delta spot within AR3559, in the northwest, has ceased to exist with the penumbra splitting apart. The whole region continues to gradually reduce its area. AR3555 is situated very close to AR3561 which makes it difficult to determine the separation, and these could be considered one region. The remaining spot regions are small and simple at present, with AR3556 almost fading from sight.

Activity has declined over past few days, but is expected to be Low to Moderate with a chance of isolated M-flares and a slight chance of an X-flare. These most likely from AR3559 and AR3561, but also potentially from new regions that are likely to imminently rotate onto the visible disc.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	45	45	45	45
Very Active	R3 to R5 X Class	No	5	5	5	5

Solar Radiation Storms - (High Energy Protons):

GOES18 high energy (greater than 10MeV) proton flux is at background levels.

There is a slight chance of radiation storms throughout due to both AR3559 and AR3561 being located in the western hemisphere. Both of these regions are magnetically complex, with a risk of an increase in proton flux should they produce any larger flares. However, AR3561 rotates off behind the visible disc tomorrow, and therefore the probabilities of a radiation storm decrease later in the period.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	10	10	5	5
Very Active	≥ S3 *	No	1	1	1	1

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	10	10	5	5
Very Active	$\geq \text{S3}$ *	No	1	1	1	1
* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)						

High Energy Electrons Event ($\geq 2\text{MeV}$):

The high energy electron (greater than 2MeV) flux is uncertain due to the effects of multiple possible CME glancing blows on the forecast, but will most likely remain at background levels for much of this period. Towards the end of the period, as CME effects are starting to wane, then electron flux may start to rise. A rise in the high energy electron flux could be aided by the potential arrival of a HSS through day 4 (29th), most likely from CH94 but possibly from CH95 as well.

Electron fluence is expected to stay below Active ($1\text{e}8$ integrated pfu), although with a rising trend late in the period. REFM is currently providing a good guidance, keeping the fluence well below the Active threshold. However, a slightly increasing trend is preferred over the next 3 days.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	5	10	15	20
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM model.

